Of the 119 genera common to South America and the United States 39 per cent. are recorded also from both Central America and the West Indies, 30 per cent. also from Central America, 6 per cent. also from the West Indies and 25 per cent. from neither. It is probable that the latter percentage will be greatly reduced by further exploration of the intervening regions and by revisions of taxonomy by which either these genera will be split or species from intervening regions will be united with them. However, such distribution is not unusual in other groups and can not be discussed profitably more in detail with this material. The following extreme illustrations from the Linyphiidæ may be cited. *Gonatium* with one species in Patagonia, two in northern United States (one of them also in Europe) and one in Greenland; *Gongylidiellum* (closely related to *Gonatium*) with two species in Patagonia (one of them also in Argentina) and three species from Maryland to New York; and *Minyriolus* with one species in Patagonia and one in Massachusetts.

It was noted above that only 6 per cent. of the genera common to South America and the United States are found elsewhere in the West Indies, but not in Central America. Leaving out of the question the fact that these may eventually be found in Central America, it is evident that the West Indies have not been an important highway for the interchange of Arachnid fauna. We should expect the influence it has had to be most apparent in the fauna of our southeastern states, but only one out of 62 genera common to that region and South America is found in the West Indies and not recorded from Central America, while 35 per cent. of them are found in Central America and not recorded from the West Indies. This one genus is *Bolostromus* with one species (*B. fluviatilis*) recorded from Alabama, one (*B. insularis*) from St. Vincent and four from South America.

Therefore, making all allowances for deficiencies in taxonomy, records and my analysis of the records, we must conclude that practically the only interchange of spiders between the two continents has been by way of Central America.

Frank E. Lutz

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
SECTION D

Professor O. P. Hood, mechanical engineer for the Bureau of Mines, was elected vice-president of the association and chairman of Section D for the next meeting, at Atlanta. Professor A. H. Blanchard, of Columbia University, was elected secretary for five years to succeed G. W. Bissell, whose term expired. G. W. Bissell was elected a member of the council for the Atlanta meeting, and Mr. W. Bowie a member of the sectional committee for five years, *vice* A. H. Blanchard, whose term expired.

The section held meetings on January 2 and 3 for the presentation of papers. Vice-president J. A. Holmes, chairman of the section, presided on January 2, on which date the program was of a general character. Professor A. H. Blanchard presided on January 3 for two sessions devoted to papers on highway engineering. January 4 was assigned as a field or inspection day for those interested in good roads.

Retiring vice-president C. S. Howe, owing to absence on leave from Case School of Applied Science and other duties, did not present an address before the section.

The section is under obligations to the local committee and the authorities of Case School of Applied Science for the very excellent facilities for meetings; to those who, although not members of the association, contributed papers and discussions, and to those of its own membership who responded to requests for papers.

The secretary is indebted to Professor A. H. Blanchard for material assistance in the preparation of the program.

The Cleveland meeting of Section D was very encouraging to those interested, notwithstanding the storm on January 3 materially reduced the attendance.

Abstracts and titles are listed below by groups.

MISCELLANEOUS PAPERS AND TITLES

The Precise Level Net of the United States: Wm. Bowie, inspector of geodetic work, Coast and Geodetic Survey, Washington, D. C.

The Coast and Geodetic Survey has recently made an adjustment of the different loops or circuits or leveling forming the precise leveling net of the United States, which will give the most probable values for the elevations of bench marks. The datum used is mean sea level, and it is assumed that the mean levels of the Atlantic, Gulf of Mexico, and Pacific are in the same level surface. Deviations from this condition, if there are any, are not greater than the accumulated errors in a line of leveling joining any two of these bodies of water.

There are 44,720 kilometers (27,790 miles) of leveling, run in two directions, and about 10,700 permanent bench marks involved in the precise leveling. There is now precise leveling in all except seven states in the United States and the net is of such strength that the elevations resulting from the recent adjustment will probably be held as *standard* elevations for an indefinite time. This will be a great benefit to surveyors and engineers who experience great difficulties when the elevations of bench marks are changed or placed on different data. Theoretically, with each new loop added to the level net, new and better values for each bench mark may be obtained by an elaborate adjustment of the net, but the change from the old value would, in nearly all cases, be exceedingly small and insignificant, as far as engineering and surveying needs are concerned. The plan adopted by the Coast and Geodetic Survey is to hold fixed the old leveling and to fit any new sections to it. From time to time adjustments of the net will be made from which to obtain the theoretically best values of the junction points in the net, which will be of scientific interest only, and the resulting elevations would be needed for surveying and engineering purposes.

The Use of Logarithmic Coordinates in the Laboratory: D. MOOMAW, assistant professor, applied mechanics and hydraulics, Case School of Applied Science.

Presentation of diagrams, showing, on logarithmic cross-section paper, the method of determining the coefficients and exponents of curves of the second and third degrees, such as represent sometimes the relations between physical quantities in experimental work in the engineering or physics laboratory.

The observed values are plotted on logarithmic paper and the method applied simply and quickly.

The Michigan Industrial Compensation Act: G. W. BISSELL, dean of engineering, Michigan Agricultural College.

The most striking as well as the strongest feature of the law is that, except for farm and domestic help, the defenses of contributory negligence, negligence of fellow servant and assumption of inherent risks, are denied to the employer. The workingmen's compensation and employers' liability act has been in operation in this state about two and one half months, and so far the material provisions of the law and the machinery provided for its operation seem to be well adapted to carry out and make effective the general purposes of the statute. It is a well-constructed and workable act in its general features, and should be given a fair trial in its present form before any attempt is made to materially amend it. The general acceptance and approval of the law by a vast majority of the employers of labor in the state, and its approval by workingmen generally, constitute persuasive evidence that the act in its present form substantially meets the requirements and performs the functions intended.

California Electric Furnace Pig Iron: F. C. LANGENBERG, Athens, Ohio.

A brief account of electric furnace reduction in California and Sweden is given with a comparison of the practices in the two countries. A brief outline is given of the California furnace: (1) description of the furnace and electrical equipment, (2) operation and product of the furnace.

Part Two deals with a microscopic study of pig irons. Two samples of California iron are discussed and their chemical and physical properties predicted by the aid of the microscope. These predictions are confirmed by analyses. The influence of the rate of cooling on the size of the graphic flakes is also shown.

Present Status of the Gas Turbine Problem: F. C. WAGNER, professor of mechanical engineering, Rose Polytechnic Institute.

It seems probable that with the gas turbine, as in the case of the steam turbine, the most profitable field will be in large units, when large volumes can be handled with a relatively small machine. In large installations, also, it would be worth while to install apparatus for saving the heat in the exhaust gases.

Altogether the gas turbine art has made substantial progress during the past year and the outlook for practical development in the near future seems especially favorable.

Notes on Some Properties of Explosive Mixtures of Air and Gas: F. H. VOSE, professor of mechanical engineering, Case School of Applied Science.

The paper refers particularly to some experiments performed with explosive mixtures of air and illuminating gas. These experiments were conducted at Washington University, St. Louis, Mo., the gas used being the illuminating gas from the city mains.

The investigation was undertaken to determine the effect of the presence of water vapor on the properties of explosive mixtures, such as pressure ratio resulting from combustion as well as the time increment involved for the completion of combustion.

While the investigation covered a wide range of mixtures, the paper was written to cover a mixture containing 4.75 parts of air to 1 part of gas by volume. This mixture approximates the theoretically best mixture for complete combustion.

Pressure rise was measured by means of the ordinary gas-engine indicator and time records obtained from tuning-fork records on the indicator card. The indicator drum was driven at a constant rate.

Slides made from original cards are shown to indicate the character of the results. Curves were also presented giving the results in graphic form.

When water vapor is present in the ratio of 0.05 parts by weight to the gas mixture a pressure ratio from explosion = 5.5 results; when the quantity of water vapor present represents 0.35 parts by weight the pressure ratio resulting from explosion is only 2.3. The retarding effect on flame propagation is correspondingly great.

The Manufacturing Organization: HUGO DIEMER, State College, Pa.

Organization defined, Organization distinct from system and management, To lay out a new organization or to analyze an existing one, Numerical military type, Specialized type, Functionalized type, Staff principle applied to industry, Selecting the type or organization and control to be applied to a given industry, Determining the will of the organization as a whole, Setting forth specific duties, A typical conventional industrial organization, Department of records, Department of materials, Department of plant, equipment and processes, Routing, Scheduling, Motion and time studies, Preparing instruction, instruction cards and instruction sheets, Standardization of equipment, Department of men, Hygiene and efficiency, Psychology and efficiency, Industrial education, Development of loyalty through social and religious activities, Line organization, Progress of an order through an industrial establishment, Carrying into effect the above principles.

A Further Analysis of the Deflections and Stresses in Reinforced Concrete Floor Slabs Constructed on the Turner Mushroom System: H. T. EDDY, dean of the graduate school, University of Minnesota.

At the Washington meeting last year the present writer gave an account of his success in developing a rational analysis of this kind of flat slabs. That analysis was based upon the application of the theory of circular plates to this form of construction.

In making such application, it is implicitly assumed that any one of the panels of a slab is supported by surrounding columns in such a symmetrical manner that the central part of a panel carries its loading approximately in the same manner as a circular plate would do when suitably supported at its circumfernce. This supposition will be nearly exact at points near the center of the panel and less so the greater the distance from the center.

Again the part of the slab at and near a column head in a slab of many continuous panels will have the loading and supports so symmetrically disposed about it that it will act nearly like a circular plate with a central support at the column, at least for points near the column.

While the application of these principles was found to give sufficiently precise values of the central deflections of panels, and of the stresses at the same points, and over the columns, at other points than these the results were not and could not be expected to reproduce the results of tests. It therefore appeared desirable to develop a more closely approximate general theory of the flexure of the reinforced concrete flat slab.

The writer has had unexpected success in developing this general theory from the fundamental differential equation of flexure of slabs, by the help of which its deflections at any points are readily computed, as well as the stresses in reinforcing rods and concrete, notwithstanding the extreme irregularity of distribution of the reinforcement. This last fact requires certain hypotheses in the adaptation of the general solution for a uniform slab to the actual slab, which are proved to be admissible approximations by the agreement of actual tests with numerical computations.

Many interesting and unexpected results appear as part of this investigation whose main conclusions have been already reached. Among these is the fact that the point of maximum stress in steel is midway directly between columns and not at the center of the panel.

It is the intention of the writer to prepare and publish a treatise upon this subject after concluding his investigations upon flat slabs and upon the theory of combined beam and slab floors. These forms of construction have been ordinarily treated by American engineers by applying some form of beam theory to their computations. This has been a fruitful source of bad design and error, because in beam theory the moment of the applied forces is equal to that of the resistance of the beam,whereas in slab theory such an equality does not exist, since these may differ by 100 per cent.

It has been found that slabs are in fact perfectly safe which beam theory would regard as far otherwise. Correct theory is therefore of extreme importance in slab design.

The Significance of Empirical Tests to the Application of Explosives in Practise: CLARENCE HALL, U. S. Bureau of Mines, Pittsburgh.

Read by title.

Sampling Coal Deliveries: G. S. POPE, Washington, D. C.

Read by title.

Smoke Prevention in Cleveland: E. P. ROBERTS, city smoke inspector, Cleveland, Ohio.

A brief account of the routine of city department of smoke inspection and results accomplished at prominent plants, with locomotives and steamships.

When possible plans for boiler settings are reviewed before installation to prevent unnecessary expense to the owner.

Cleveland has noticeably improved in the matter of smoke during the past few years.

Mr. Roberts also exhibited a novel and valuable smoke chart intended to overcome the objections to the Ringelman charts.

PAPERS ON HIGHWAY ENGINEERING

Bond Issues for the Construction of State Highways: JAS. R. MARKER, state highway commissioner, Columbus, Ohio.

Read by title.

The Design of Various Types of Highway Bridges from the Standpoint of Modern Traffic: FRANK H. NEFF, professor of civil engineering, Case School of Applied Science, Cleveland, Ohio.

Subject discussed at length by the author and liberally illustrated with lantern slides.

Methods of Repairing Cement Concrete Pavements: FRANK F. ROGERS, deputy commissioner, State Highway Department, Lansing, Mich.

In practise repairs to these pavements are made by two distinct methods, depending on whether the defects are on the surface or extend deeper into the mass. Surface treatment is given by first cleaning the defective places, then filling, or covering them with hot bitumen, preferably refined tar, and coating with sand. This applies to wear at the expansion joints and to cracks caused by natural causes as well as to a pitted condition of the surface, and tends to prevent further deterioration of the places repaired. As a rule, repairs of this kind have to be made annually. In Wayne County, Michigan, the cost of such repairs has been about $50 a mile. When the defects lie deeper a portion of the concrete is chiseled out, usually to the sub grade, the exposed edges thoroughly cleaned and given a wash coat of neat cement, after which the excavation is filled with the same kind of concrete that was used in the original construction. Repairs of this kind generally prove satisfactory. Bellefontaine, Ohio, reports that repairs on 4,400 square yards of cement concrete pavement laid in 1893 and 1894 have cost only about $200.

Relative Advantages of Laying Brick Pavements on Sand Foundations and Cement-Concrete Foundations: ROBERT HOFFMAN, chief engineer, Department of Public Service, Cleveland, Ohio.

Relative economy of using a sand or concrete foundation for a brick pavement depends upon its first cost, cost of maintenance and life. Accurate data relative to maintenance and effect of traffic is not at hand. Records of cities which show the time that has elapsed between the laying and relaying of a pavement affords the best available evidence upon which to base estimates of relative economy.

In Cleveland, which is chosen as a representative city with reference to brick paving, prices paid per square yard of brick pavement, have varied as follows:

5 in. brick laid on natural sand foundation, $1.18 to $1.56.

5 in. brick on 8 in. sand or gravel ballast foundation, $1.40 to $1.97.

5 in. brick on 6 in. concrete foundation, $1.94 to $2.48.

4 in. brick on 6 in. concrete foundation, $1.71 to $2.34.

4 in. brick on 4 in. concrete foundation, $1.47 to $1.73.

During the last three years the following average price has been paid.

5 in. brick laid on natural sand foundation, $1.27 per sq. yd.

5 in. brick on 8 in. sand or gravel foundation, $1.58 per sq. yd.

4 in. brick laid on 4 in. concrete foundation, $1.60 per sq. yd.

Average life of five inch brick on sand foundation is taken from the city's experience to be fifteen years. Four-inch brick on sand foundation is assumed as twelve years. From this data it is calculated that four-inch brick can be laid on four-inch concrete as economically as the five-inch on natural sand foundation if the life will be twenty-two years. Four-inch brick can be laid on six-inch concrete as economically as five-inch brick on eight inches of sand or gravel foundation if its life is eighteen years.

It is concluded that when conditions are favorable a five-inch brick laid upon a good natural sand foundation will form the cheapest form of brick pavement, but in all other cases one with a concrete foundation will prove the most economical.

Some Considerations Affecting the Interaction of Motor-vehicle Wheels and Road Surfaces: DR. L. I. HEWES, chief, division of economics and maintenance, Office of Public Roads, U. S. Department of Agriculture, Washington, D. C.

In this paper, the author suggests the fundamental work equation

$$(1) \qquad \frac{h}{v}=f,$$

where h is effective horsepower developed at the tires of the motor wheels of an automobile, v is the velocity, and f the total resistance. This equation obtains on a level at constant speed and with the air resistance neutralized by a wind current parallel to the velocity of the machine. It is important to determine the nature of the resistance f, which is in a sense a road coefficient, as it must vary for the same automobile on different roads. The resistance to the motion above described can not be solely due to the action of gravity on the weight of the machine as much as assumption demands a constant resistance for all speeds on the same road. A table is presented showing the relation between effective horsepower, velocity and resistance of traction. This table was published in *Le Genie Civil*, Vol. LXI., No. 14, p. 276, and exhibits the relation of equation (1). It is the record of tests made in 1912 in Paris on a Berliet truck.

The author discusses two sources of resistance which must be included in the symbol f. First the resistance which is developed by the motion of the points on the automobile tire not in contact with the ground and which strike small particles with a positive forward velocity. It is pointed out that a point on the periphery of a tire moves in a cycloid and at the instant of contact has zero velocity, whereas points immediately adjacent to the periphery and not in contact with the ground move in rolling curves with velocities having considerable horizontal components which may produce small and continuous shocks, which, owing to the varying magnitude of the velocities in the same vertical cross-section, can produce twisting action upon small particles comparable to the "English" of a billiard ball and thus throw small material to one side of the path. Table of velocities of points at varying vertical distances from the road surface follows. A second source of resistance is described. This resistance is due to the fact that the pneumatic tire which is in the form of a torus is not applicable to road surfaces without deformation. The increment of tensions in the tire material due to such deformation is described and it is pointed out that such rubbing action on the road surface, while simultaneous, is continuous and the sum of such effects must cause a portion of the resistance f. The author concludes that on account of both sources of resistance it is desirable to preserve the enamel of the road surface intact and free from all loose particles, and further that the interaction of road and tire must continue unfavorable both to road and tire, unless the section of the tire is made trapezoidal.

Bituminous Surfaces on Brick Pavements: ELLIS R. DUTTON, assistant city engineer, Minneapolis, Minn.

The use of a bituminous coating on the surface of old and new brick paving is desirable and beneficial. It gives a more pleasing appearance to the street, reduces the noise, affords better foothold for horses—and lessens the wear of the brick.

A bitumen which would be satisfactory for this purpose should be of a very adhesive quality all the time, under all conditions of moisture and temperature, and should not become excessively

soft in hot weather—nor become brittle in cold weather.

It should be composed of such materials that would be and remain stable under all conditions and not evaporate or lose its most valuable properties.

It should be applied in the best and most approved manner, so as to produce the best results capable for the quality of the bitumen. The surface of the brick should be made perfectly clean, free from dust and moisture. The bitumen should be applied at the proper temperature—in a proper manner and under favorable weather conditions.

After application of the bitumen the surface should be covered with either fine granite or trap chips, torpedo sand or a coarse sand.

Such a bituminous coating would make the ideal brick pavement.

Small Stone Block Pavements: A. H. BLANCHARD, professor of highway engineering, Columbia University, New York City.

Illustrated with lantern slides of European and American pavements of this type.

The Organization of Town Highway Departments: FRED BUCK, assistant deputy commissioner, New York State Highway Department, Albany, N. Y.

There are three essential points to be observed in formulating any plan for the improvement of the highways of any commonwealth.

(*a*) A series of improved thoroughfares connecting the principal centers of population.

(*b*) A series of improvements to the highways which form the principal tributaries to those first mentioned.

(*c*) All highways in the commonwealth not included in the first two classes.

No plan for financing a scheme of highway improvement has yet been advanced which will make possible the improvement of a total of more than 12 per cent. of the mileage of any state, of the character indicated for classes (*a*) and (*b*) within the next 15 or 20 years; and any plan which contemplates the improvement of 12 per cent. of the mileage of any commonwealth without giving attention of some kind to the remaining 88 per cent., fails in large measure of attaining its full value to the commonwealth as a whole.

Roads comprising class (*c*), in this article, are, in the state of New York, under the jurisdiction of the Bureau of Town Highways, and since the organization of that bureau, very gratifying results have been accomplished.

With no greater town taxes than were raised under the old "Labor System," about 3,600 miles of good town macadam roads have been built, about 8,400 miles of good gravel roads, and about 50,000 miles have been properly shaped and crowned and standardized as to width.

By furnishing plans and encouraging town superintendents to construct culverts and short-span bridges with their own local labor, utilizing local materials wherever possible, in 1911 there was effected a saving, in actual cash, to the taxpayers of the state more than three hundred and fifty thousand dollars, not taking into any account the vastly superior strength and durability of the structures so erected.

The results of the plan in New York seem to clearly prove that a thoroughly organized, well equipped town highway department is one of the essential parts of any general scheme of highway improvement.

Brick Pavements for County Highways: W. C. PERKINS, Niagara Falls, N. Y.

Presented by the author, and illustrated by lantern slides.

A City Traffic Census: W. H. MESSENGER, S.B., assistant engineer, Bureau of Highways, Brooklyn, N. Y.

The above bureau inaugurated a permanent census of its vehicular traffic in June, 1912. The forms used divide traffic into two large classes, rubber-tired and iron-tired, with appropriate subdivisions of each class. Starting with a small squad of six men, working eight hours a day, rain or shine, observations have been made at some 400 points mostly in duplicate. Duplicate observations are separated by a period of 15 days. A few night and Sunday records have been taken.

Results are tabulated to give the density and tonnage. The density is computed for number per foot of roadway per minute, per line of traffic per minute, and on the basis of traffic units as used by the London Traffic Branch. Tonnages are founded on extensive inquiry among those best knowing weights of different vehicles of business and recreation, and are assembled to give daily, weekly and annual amounts per foot of width of roadway, to the end that durability or total life may eventually be found for all classes of pavement.

The results thus far obtained have been used by the city planning committee, and are daily called for in connection with the determination of the class of pavements to be laid on certain streets in the immediate future.

This census was inaugurated by Mr. H. H. Schmidt, chief engineer, and placed under the charge of the writer.

Petrographic Study of Rocks for Road-making in the Office of Public Roads: E. C. E. Lord, petrographer, U. S. Office of Public Roads, Washington, D. C.

This paper contains a review of a quantitative, microscopic method of rock analysis by means of a cross-line field, and a brief statement of the principal road-making rocks, their method of classification and physical properties. Attention has been called to the effect of mineral composition and rock structure on the wearing properties of road materials.

It has been shown that the dense, fine-grained, igneous rocks (traps) are generally more tough and offer greater resistance to wear than the coarser grained igneous, or the more loosely textured sedimentary and metamorphic rocks. In consequence of their superior toughness, the screenings from trap rocks are found to be sharper and more wedge-shaped than those from other rock types and therefore produce a more permanent bond when compacted with the larger road stones.

This interlocking of the coarser portion of the screenings with the rock fragments forming the wearing course of the road constitutes the mechanical bond of the road surface, and should be distinguished from the cementing bond of the fine dust which is due to the presence of adhesive mineral substances of a more or less colloidal character. This cementing value has been found insufficient in many cases to withstand the effect of modern traffic and it has therefore been suggested to make use of the highly cementatious basic open hearth slag dust to overcome this difficulty.

Field Methods for Laying Out Highway Curves: Henry B. Drowne, instructor in highway engineering, Columbia University.

Read by title.

The Value of Microscopic Analysis of Rocks to be Used in the Construction of Roads and Pavements: J. F. Kemp, professor of geology, Columbia University.

Read by title.

Municipal Plants for the Storage of Road Oil: William H. Kershaw, chief engineer, Paving and Roads Division, The Texas Company, New York City.

After comment on the existing conditions regarding the lack of equipment for storing road oil, with its resulting economic loss, detailed statements of the cost of tankcar equipment is given, showing that all extra expense in the handling of road oil that results from lack of proper storage facilities eventually becomes a part of the cost of the oil. Figures given show that 12,000 gallon tanks can be erected at an approximate completed cost of $700. A statement is made that the saving of the accumulating demurrage now charged by the railroads will pay for the erection of the tank and the saving in the cost of the oil will show an earning on the investment.

After describing existing municipal storage plants, a simple form of single compartment tank is suggested that will hold 12,000 gallons and is fitted with steam coils and on which all outside piping is steam jacketed, which will cost complete approximately $700 and is capable of handling all of the heavier grades of binding oils and solid bitumens as well as the lighter grades of road oil.

The Consistency of Bituminous Materials, its Determination and Value in Specifications: Major W. W. Crosby, chief engineer to the Maryland Geological and Economic Survey, and consulting engineer, Baltimore, Md.

The consistency of a bituminous material is defined as its degree of firmness and determined by internal friction.

The determination of consistency is now usually made by one or more of half a dozen instruments designed on three general principles.

The instruments described, however, do not now cover in their range the entire field of materials and some materials are difficult of measurement in the matter of consistency by any of the older and more customary instruments.

The desirability of a single instrument for the purpose, whose range will cover readily the entire field of materials, is evident. Two such, newly proposed and as yet not generally used, are described. A modification in the customary methods of performing certain tests is advocated.

The value of a proper determination of consistency is shown by the dependence, on this characteristic, of the methods of using a material, by the information which such a determination gives concerning the probable results of such use, and concerning the value of the material itself.

Specifications containing definite descriptions of

the consistency of a pitch and drawn in physical terms are particularly appropriate for physical work such as road-building, and such specifications are more likely to be readily understood than where chemical expressions are used, perhaps to cover the same points in a less direct way.

The writer believes that valuable research work can be done by investigations into the consistency of bituminous materials or pitch compounds, and that from such work the art of road-building will be advanced.

The Value of Specifications and Tests for Bituminous Materials: CHARLES S. REEVE, chemist, U. S. Office of Public Roads, Washington, D. C.

The author urges the importance of purchasing bituminous materials upon a specification. The maker of such a specification, however, should know the relations to one another of the particular characteristics he demands, and the ability of the producer to meet his requirements. Advance samples and shipments should be tested to insure the acceptance of satisfactory material and to furnish records of tests which may prove of value later. Examples of recent neglect to fulfil certain specifications are given, and in some cases this neglect would have proved serious but for the fact that careful inspection averted the use of the undesirable materials. The practise of purchasing upon a trade name only is criticized, and an example is cited which shows a recent failure due to this practise. The author concludes by urging the highway engineer to protect himself by the careful purchase and inspection of materials.

The Evaporation of Bituminous Materials, its Determination and Value in Specifications: PREVOST HUBBARD, in charge Division of Roads and Pavements, The Institute of Industrial Research, Washington, D. C.

Read by title.

Fixed Carbon in Bituminous Materials, its Determination and Value in Specifications: LESTER KIRSCHBRAUN, director, Chicago Paving Laboratory, Chicago, Ill.

The writer describes the standard method of determining fixed carbon in bitumens, and points out some of the factors of manipulation necessary of observance in order to obtain correct and consistent results. A discussion of the derivation of fixed carbon produced upon ignition of bitumens is given, and its significance applied in three particulars. First, as a means of identification of certain native bitumens; secondly, as a means of checking the suitability of combinations of flux solvents with hard, highly condensed bitumens; and again, as applied to oil asphalts, as an index of the severity of heat treatment to which such materials have been subjected in the course of their production. This latter feature is demonstrated by graphical data showing the effect upon the fixed carbon yield in runs of oil asphalt made from the same crude at different temperatures. The effect of the character of the crude from which these products are made as influencing the fixed carbon characteristics, and the application of this test to specifications, is pointed out.

A Method for Determining the Toughness of Bituminous Materials: J. E. MYERS, chief chemist New York State Highway Department, Albany, N. Y.

The toughness of bituminous materials is determined by filling a 3 oz. tin box (3.5 cm. deep by 5.5 cm. in diameter) with the melted material. The material is allowed to cool to room temperature. When cold the box is held by a pair of tongs, rapidly heated over a Bunsen burner, and the material emptied into a can of cold water. In heating, only enough heat is applied to free the material from the box, so when emptied into the water the material is still solid, being softened only on its exterior. By wetting the hands this cylindrical shaped piece of bitumen is easily rolled into a ball which will be free from seams.

The ball is maintained at the temperature at which the test is to be made (usually at zero degrees C.) for at least one hour before testing. The balls are tested in the impact machine adopted by the American Society for Testing Materials, for determining the toughness of rock used in macadam roads. The essential working parts of the impact machine are the anvil, of 50 kilograms weight; the hammer, of 2 kilograms weight, and the plunger, of 1 kilogram weight, the plunger having a hemispherical-shaped head of 1 cm. radius.

In testing asphaltic materials the drop of the hammer is taken from a height of 5 cm. for the first blow and the drop of each succeeding blow is increased 5 cm. The height from which the hammer falls when rupture occurs is given as the toughness of the material.

Distillation of Tar. Methods of Determination, and Value in Specifications: PHILIP P. SHARPLES, chief chemist, Barrett Manufacturing Co., Boston, Mass.

The methods in use and proposed for the distillation of tars and refined tars in road work are so varied and give such varied results that there is urgent call for their standardization. Attention is called to the excellent work of the Subcommittee on Distillation of Committee D—4 of the American Society for Testing Materials and their recommendations.[1]

The distillation test in a specification should be so drawn as to show, in conjunction with the free carbon, specific gravity and viscosity: (1) absence of water; (2) character of tars used; (3) method of refining. It is important that in addition to the amount of distillate, its specific gravity and the melting point of the residue be required.

Classification of Rocks Used in the Construction of Roads and Pavements: Charles P. Berkey, assistant professor of geology, Columbia University.

Read by title.

Specifications for Patented Pavements: William H. Connell, chief, Bureau of Highways and Street Cleaning, Philadelphia.

Read by the secretary.

The History of the Topeka Bituminous Concrete Pavement: Theo. S. DeLay, city engineer, Creston, Iowa.

In the early days of the use of bituminous paving surfaces various arrangements of aggregate and various bituminous materials were used, the materials and methods being adapted to the work contemplated.

About the year 1893 Marcus A. Hodgman, a paving superintendent, in the employ of F. O. Blake, in Denver, reverted to some of the earlier practises in laying bituminous pavements.

Hodgman's work was seen by Frederick J. Warren, an employee of the Barber Asphalt Paving Company, who subsequently resigned from the employ of that company, went east, and took out a patent on a similar form of construction.

Warren organized the Warren Brothers Company to promote the invention and by vigorous promotion methods succeeded in having built a very considerable yardage of paving in accordance with this method.

Hodgman died in 1903, but Blake continued in the paving business and evidently still had a good opinion of Hodgman's idea, as he promoted some pavement in accordance with that principle in Topeka, Kansas, about the year 1908.

Before this work was constructed, Warren Brothers Company brought suit for infringement of patent against the city of Topeka and the contractor. The defendants called on Blake for assistance to such good purpose that, when the case came up for trial, the plaintiff was willing to enter an agreed decree waiving claim of infringement but enjoining plaintiff against infringing.

Early in 1910 the city of Creston, Iowa, started proceedings for the construction of 25,000 yards of bituminous concrete paving and adopted the specifications used at Topeka. Creston also was made defendant in a suit by Warren Brothers Company, and this was settled by an agreed decree as in the Topeka case, but without any injunction clause.

Since it has become known that this form of pavement is free of difficulties it has been used very extensively in the middle west, with general satisfaction. It is not, however, a new form of construction, as it has been in continuous use in Pittsburgh, Pa., since 1897.

Its use has been instrumental in greatly reducing the cost of paving to the taxpayer, as may be seen by comparing prices at Creston with those of other places.

As this form of construction yields no exorbitant profits it has no promoters, hence has not met with acceptance as rapidly as its merits deserve.

It is subject to one objection common to all continuous pavements, namely, cracking under sudden changes of temperature. These cracks do no harm, show no inclination to ravel, and close up during warm weather when sufficient traffic passes to keep the pavement worked.

Economical Methods of Repairing Sheet Asphalt Pavements: H. B. Pullar, assistant manager and chief chemist, The American Asphaltum and Rubber Co., Chicago.

Read by title.

Limitations in the Use of Bituminous Carpet Surfaces: Arthur W. Dean, chief engineer, Massachusetts Highway Commission, Boston.

Read by title.

The Maintenance of Bituminous Pavements: Jas. C. Travilla, street commissioner, St. Louis.

Read by title.

Observations on Slipperiness of Bituminous Surfaces and Bituminous Pavements: W. D. Uhler,

[1] *Proceedings of the American Society for Testing Materials,* Vol. XI., 1911.

assistant chief, Bureau of Highways and Street Cleaning, Philadelphia.

Read by title.

The Mixing Plants Used in the Construction of the Topeka Bituminous Concrete Pavements of the Borough of Queens in 1912: A. F. GRUENTHAL, assistant engineer, Bureau of Highways, Borough of Queens, N. Y.

Read by title.

Bituminous Gravel Concrete Pavements: SPENCER J. STEWART, division engineer, New York State Department of Highways, White Plains, N. Y.

This pavement consists of mixing Hudson River cementatious gravel, heated to a temperature of over 225 degrees F., with natural lake asphalt heated to a temperature of not less than 275 degrees F., then placing both ingredients in a mechanical revolving mixer and thoroughly agitating until all the particles of the mineral aggregate are thoroughly and completely coated with the bituminous material.

This mixture, at not less than 250 degrees F., is then spread upon the prepared bottom or foundation course.

The gravel is composed of calcareous sandstone, granite and quartzite, associated with a considerable amount of finer particles of the above-named rocks, together with a percentage of clay. This latter substance gives the gravel a good cementatious value, which is an essential to the comparative permanency of the pavement. The clay acts as a catalyzer on the asphalt, making it more viscous, less volatile and also less brittle.

The advantages of this pavement are:

First, its comparatively low cost over so-called semi-permanent pavements.

Second, on account of its adaptability to country and parkway purposes, due to its easy riding surface and its conformity to our ideals of the surroundings of a parkway or country highway.

Third, on account of its non-slippery nature, it being practically a "non-skid" road.

From the contractor's bids, the average cost of this pavement is about $0.85 per square yard.

A Review of the Use of Bituminous Materials in the Construction and Maintenance of American Highways during 1912: ARTHUR H. BLANCHARD, professor of highway engineering, Columbia University, New York City.

G. W. BISSELL,
Secretary

EAST LANSING, MICH.,
March 10, 1913

SOCIETIES AND ACADEMIES

THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

THE fifteenth regular meeting of the society was held at the residence of Dr. Ransom, March 20, 1913, Dr. Ransom acting as host and Mr. Chambers as chairman.

The comparative anatomy of the free-living and the parasitic nematodes was discussed by the society.

Mr. Crawley presented a note reviewing Muriel Robertson's work on *Trypanosoma gambiense* and its vector, *Glossina palpalis*. She has shown there is a rhythmic cycle in the life of the trypanosome in the vertebrate host, the parasite falling off in numbers at times until there are only a few small forms present, which then begin to multiply with a resultant production of larger forms until the blood contains numerous large forms, and the cycle repeats. An endeavor to correlate this alternation of few small forms and numerous large forms with the infectivity of the trypanosomes for its invertebrate host, the tsetse fly, developed the fact that the infectivity was at its maximum when the few small trypanosomes were in the blood and at its minimum when the many large forms were present.

Dr. Ransom presented a note on "The Reported Hosts of *Cysticercus cellulosæ*." It is commonly stated in general works on parasitology that *Cysticercus cellulosæ* occurs not only in the pig, its usual host, and in man, a not uncommon host as a result of auto-infection, but also in the dog, cat, bear, sheep, deer, rat and monkeys. It has also been reported from a seal.

The only hosts, however, in which the occurrence of *Cysticercus cellulosæ* can be considered to have been proved are the first three named. The reputed occurrence of *C. cellulosæ* in the cat, bear, rat and seal rests apparently upon a single instance of the discovery of cysticerci resembling *C. cellulosæ* in these hosts without proof by feeding experiments. Likewise, though several cases of *C. cellulosæ* have been reported from monkeys and rather many cases from sheep and deer, no experimental proof or other evidence of a conclusive nature that the parasites in question were really *C. cellulosæ* has been furnished. On the contrary, the evidence thus far available tends to prove the non-occurrence of *C. cellulosæ* in these animals, particularly in the case of sheep and deer. It has, in fact, been recently shown (Ransom, 1913) that the muscle cysticercus of sheep